

Aviation Systems Division (Code AF) FY12 Technical Highlights

Air traffic management Technology Demonstration (ATD)-1

The AF Division supported major activities that led towards the ATD-1 field demonstration planned for 2016. Simulations in support of terminal area scheduling research were performed to assess the feasibility, performance, and potential benefits of the proposed concepts and technologies. In March and September 2012, NASA Ames hosted joint simulations requested by the FAA: the RNP-Enabled by ATD-1 Controller Tools (REACT) and the Terminal Sequencing and Spacing #1 (TSS-1) simulation. Both experiments focused on a mixed equipage environment and provided useful data to the FAA. Shakedown simulations were completed towards the FY13 experiment of the Fully Integrated ATD-1 Technology (FIAT) simulation. FIAT successfully integrated the NASA Langley-developed Flight Deck Interval Management (FIM) technology with the ground-based scheduling systems in a human-in-the-loop

simulation and also utilized the research Traffic Management Advisor (rTMA) software that will be used in the eventual flight demonstration. A flight-deck simulation examined how feasible and acceptable Controller-Managed Spacing (CMS) clearances are to a B747-400 flight deck, and found that such clearances were quite manageable without additional training.

SimLabs: Vertical Motion Simulator (VMS), Crew-Vehicle Systems Research Facility (CVSRF), Advanced Concepts Flight Simulator (ACFS), FutureFlight Central (FFC)

Eighteen separate experiments were run in the SimLabs facilities in FY12 supporting numerous Aeronautics research objectives as well as outside customers investigating a diverse array of human-piloted vehicles and systems, including: rotorcraft handling qualities and a lunar lander at the VMS; an experiment on airline pilot response to emergency events at the CVSRF; and

NASAfacts



Shakedown simulations were completed towards the FY13 experiment of the Fully Integrated ATD-1 Technology (FIAT) simulation.



SimLabs outreach at the Shuttle Endeavour flyover; one of the 350 tour and events performed by SimLabs in FY12

evaluation of an airport surface scheduling tool at FFC. At the ACFS, the final Efficient Descent Advisor (EDA) simulation served as the inaugural experiment for the newly installed Boeing 737-800W model.

The SimLabs team, working with the Ames Exploration Technology Directorate and the Air Force Research Laboratory (Mesa, AZ), also completed the review, testing, and installation of the US Air Force Operational Based Vision Assessment (OBVA) simulator at Wright Patterson Air Force Base (OH). The OBVA system will aid in evaluating and reducing aircrew operational risks when performing visual tasks.

Dynamic Weather Routes (DWR)

The DWR research and development effort transitioned from laboratory testing at Ames to operational testing at the American Airlines (AA) System Operations Center in Fort Worth, TX in just 12 months. Over 150 DWR flights were evaluated by AA users since July 17, 2012; 45% of those with a total savings of 470 flying minutes were deemed acceptable to AA. Potential savings for all flights in Fort Worth Center's high altitude airspace from August through October 2012 totaled over 23,000 flying minutes for 2,600 flights which equates to a \$3.8M potential savings in airline operating costs.

Efficient Descent Advisor (EDA) Technology Transfer and Aeronautics Day on the Hill

In November 2011, NASA officially delivered its final EDA technology transfer package to the FAA's 4D-Advanced Arrivals Project, culminating several years of collaborative research and development with the FAA, including seven human-in-the-loop simulations and two field tests. EDA technology supports the FAA's Three-Dimensional Path Arrival Management (3D-PAM) concept for more fuel- and time-efficient



Dr. Jaiwon Shin, NASA Aeronautics Associate Administrator, officially hands off EDA to the FAA's Victoria Cox, Assistant Administrator for NextGen and David Grizzle, Chief Operating Officer, Air Traffic Organization, January 2012

arrival operations in congested airspace, which is also expected to be a key element in the FAA's Ground-based Interval Management system.

In July 2012, NASA demonstrated EDA in an exhibit during a first-of-its-kind event, Aeronautics Day on the Hill, held at the Rayburn House-of-Representatives building in Washington, DC. Eleven members of Congress along with Congressional staff and interns attended, representing the Senate Committee on Commerce, Science and Transportation and the House Committee on Science, Space and Technology.

Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS)

Several major test and integration activities were accomplished that establish a nationwide platform supporting joint activities from multiple facilities towards a 2015 flight demonstration goal. The Integrated Test and Evaluation (IT&E) sub-project of UAS in the NAS built a combined live, virtual (simulated), and constructive (LVC) real-time, human-in-the-loop distributed test environment that will facilitate the evaluation of candidate UAS technologies. Ames' SimLabs branch collaborated with teams at the Research Aircraft Integration Facility (RAIF) at NASA Dryden Flight Research Center, the FAA's William J. Hughes Technical Center (WJHTC), NavAir Pax River, Boeing in Palmdale and Philadelphia, the NASA North Texas Research Station, Ames' high fidelity B747-400 flight simulator, and the FAA's NextGen Integration and Evaluation Capability (NIEC) lab. In a May 2012 simulation, testing included the Dryden Ikhana UAS aircraft, which flew in a mixed simulation and live flight demonstration and downlinked aircraft telemetry data to the ground control station.



Dynamic Weather Routes tool in operation at the American Airlines System Operations Center, Fort Worth, TX

Separation Assurance (SA)

SA researchers developed a new technique to reduce climb-trajectory prediction errors by about 15% in evaluations with actual Host radar track data. The new adaptive climb-trajectory prediction algorithm improves climb-trajectory prediction accuracy by dynamically adjusting the aircraft weight modeled for trajectory predictions based on observed track data. Initial tuning of the algorithm and evaluation was conducted using Fort Worth Center (TX) air traffic data.

Super Density Operations

Terminal area research in conflict detection and resolution continued to evolve in the development of the Terminal-Tactical Separation Assured Flight Environment (T-TSAFE). Two weeks of T-TSAFE human-in-the-loop simulations were completed to demonstrate potential benefits of T-TSAFE relative to existing FAA conflict alerting capabilities. Division researchers also worked with FAA team members from the Minimum Safe Altitude Warning/Conflict Alert (MSAW/CA) Safety Board regarding the ability of T-TSAFE to address well-known issues with Conflict Alert (CA), a legacy tactical conflict detection tool currently in operational use. NASA agreed to begin analysis of Mode-C Intruders (MCI), whose alerts contribute the largest volume of CA nuisance alerts in the field.

Traffic Flow Management

Division researchers completed the 2012 operational field evaluation of the San Francisco International Airport (SFO) stratus ground delay program model, in collaboration with researchers from the FAA, Mosaic ATM, MIT Lincoln Laboratory and the National Weather Service (NWS). Preliminary results from the field assessment indicated that when Ground Delay Programs (GDPs) are planned with the model, delays were on average 1,769 minutes less per GDP, a



Test simulation of the Spot and Runway Departure Advisor (SARDA) tool in FutureFlight Central

reduction of nearly 21%. The FAA is considering the model for operational deployment. In December 2011, Dr. Banavar Sridhar, the Ames Senior Scientist for Air Transportation Systems, presented a paper at the Second Aviation Climate Change Research Initiative (ACCRI) Symposium in Washington, DC. Dr. Sridhar's paper on route optimization methods and the impact of cross-polar traffic on emissions was very well received.

Airport Surface Research

In the second in a series of high-fidelity human-in-the-loop simulations to evaluate the Spot and Runway Departure Advisor (SARDA) tool, six retired Dallas/Fort Worth (TX) tower controllers participated in a 3-week simulation at Ames' FutureFlight Central (FFC) tower simulation facility. The experiment further established SARDA benefits of reduced departure taxi delay and fuel consumption. Controllers also reported SARDA advisories were easy to use.

The Division's surface research team also participated in multiple collaboration and partnership discussions, site visits, and demonstrations with US Airways to explore airport movement challenges focused on Charlotte Douglas International Airport (CLT). Division researchers also collected data on gate, ramp, taxiway, and runway procedures at CLT and US Airways ramp tower to enhance NASA's fast-time airport flight operations simulator, the Surface Operation Simulator and Scheduler (SOSS).

Precision Departure Release Capability (PDRC)

From May-July, an operational evaluation was conducted with TMCs from Fort Worth Center and Dallas/Fort Worth TRACON and Towers who used PDRC to schedule 120 actual departures to satisfy traffic management restrictions. This is believed to be the first time that schedules with precision at the seconds

level were used for coordination in real-world, tactical departure scheduling. The results provided validation for the PDRC concept and assessed system performance and quantified the various contributors to scheduling uncertainty where used. In support of technology transfer to the FAA, in July 2012, NASA delivered an interim set of PDRC research transition products, including a Concept of Operations, Technology Description, and field evaluation results to the Integrated Arrival/Departure/Surface Research Transition Team.

Dynamic Airspace Configuration (DAC)

The DAC team continued in-depth collaborations with Cleveland En Route Center, and assisted the Cleveland Center airspace redesign team to formulate, refine, and validate their new sector designs by analyzing their sector loading patterns. Development continued on the Operational Airspace Sectorization Integrated System (OASIS), an airspace sectorization advisory tool. The OASIS algorithm and user interface are being designed and developed with input from air traffic management experts from four different En Route Centers; it is being targeted for human-in-the-loop testing in January 2013 and a field evaluation at Cleveland Center in 2014.

System Portfolio Analysis

In support of System Portfolio Analysis, an initial prototype of the Event-Based Stochastic Simulation of Terminal airspace Operations (ESSTOR) was completed. This new simulation is an extension of the Stochastic Terminal Area Scheduling Simulation (STASS), which has been used for fast-time simulations to investigate aircraft arrival concepts. ESSTOR is event based, which will eventually enable the simulation of multiple, concurrent schedulers. It currently models the FAA's Traffic Management Advisor scheduler with greater fidelity than the previous STASS simulation.

Traffic and Atmospheric Information for General Aviation (TAIGA)

The Division proposed a promising ATM solution for Alaska's unique air transportation challenges, including unusual, severe weather conditions, its tremendous dependence upon general aviation (GA) throughout the state, and the complex airspace around the city of Anchorage: The Traffic and Atmospheric Information for General Aviation (TAIGA) tool, which is now under development. TAIGA is an Android-based tool for GA pilots that will integrate and display weather, ATM, and terrain data on a smartphone device with updated

aircraft position using built-in GPS technology within the smartphone. In December 2011, Division researchers discussed TAIGA's potential and gained support from Alaska Department of Transportation managers, including the Deputy Commissioner of the Aviation Division and the Project Manager for the Statewide Mapping Initiative.

Technical Publications

The AF Division published a total of 57 technical papers in FY12, in journals, at technical conferences, and in NASA technical publication forums. Several papers were also recognized for their outstanding technical contributions with the following awards:

- 2011 AIAA/IEEE Digital Avionics Systems Conference (DASC) Best Paper in Session, "Effects of Scheduling and Spacing Tools on Controller's Performance and Perceptions of their Workload" by L. Martin, H. Swenson, A. Sadovsky, J. Thipphavong, L. Chen and A. Seo
- 2012 National Society of Black Engineers (NSBE) Aerospace Systems Conference, Outstanding Technical Contribution - Outstanding Paper: "Evaluation of a Fuel-Efficient Aircraft Maneuver for Conflict Resolution" by A. Bowe & C. Santiago
- 2012 NASA Ames Aeronautics Technical Excellence in Publications Award - "Performance Evaluation of a Surface Management Tool for Dallas/Fort Worth International Airport," by Y. Jung, T. Hoang, J. Montoya, G. Gupta, W. Malik, L. Tobias, and H. Wang

Awards and Organizational News

The Aviation Systems Division is comprised of 77 civil servants and over 130 contractors. The staff were recognized in a number of Agency and external forums, including:

- Government Invention of the Year award - Future Air traffic management Concepts Evaluation Tool (FACET)
- Todd Farley, AFT Branch Chief, received the Aeronautics Research Mission Directorate (ARMD) Agency award for Leadership and Management Excellence.
- National Society of Black Engineers (NSBE) Aerospace Systems Conference 21st Century Trailblazers in Aerospace Award, Aerodynamics & Aviation to Ousmane Diallo and Aisha Bowe

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www.aviationsystems.arc.nasa.gov

National Aeronautics and Space Administration

Ames Research Center

Moffett Field, CA 94035

www.aviationsystems.arc.nasa.gov

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